

CLAIM AMENDMENTS

This listing of claims will replace all prior versions, and listing, of claims in the application:

Listing of Claims:

Claim 1 (currently amended): A variable displacement vane pump, comprising:

a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction; and

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction;

wherein control and positioning of the first and second actuators are a function of a combination of a first ~~feedback~~ pressure signal and a second ~~feedback~~ pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit;

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 2 (previously presented): The pump of claim 1 wherein the first actuator is a piston slidably carried by the housing.

Claim 3 (previously presented): The variable displacement vane pump of claim 1 wherein the second direction is in a direction opposite of the first direction.

Claim 4 (previously presented): The pump of claim 1 wherein the second actuator is a piston slidably carried by the housing.

Claim 5 (canceled)

Claim 6 (previously presented): The pump of claim 1 wherein the first actuator includes a spring that in yielding biases the containment ring or eccentric ring in the first direction.

Claim 7 (currently amended): The pump of claim 1 which also comprises a seal between the containment ring or eccentric ring and the housing ~~defining a fluid chamber between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator.~~

Claim 8 (currently amended): The pump of claim ~~7~~ 1 which also comprises another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator.

Claim 9 (canceled)

Claim 10 (previously presented): The pump of claim 1 which also comprises a pivot pin about which the containment ring or eccentric ring pivots, the pivot pin defining a pivot axis of the containment ring or eccentric ring which is offset from the axis of the

rotor by about one-half the maximum eccentricity of the containment ring or eccentric ring relative to the rotor.

Claim 11 (original): The pump of claim 1 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 12 (original): The pump of claim 11 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 13 (original): The pump of claim 1 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 14 (original): The pump of claim 13 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 15 (previously presented): The pump of claim 1 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 16 (currently amended): The pump of claim 7 1 wherein the seal is defined by direct contact between the containment ring or eccentric ring and the housing.

Claim 17 (currently amended): The pump of claim 7 1 wherein the seal is carried by the containment ring or eccentric ring.

Claim 18 (currently amended): The pump of claim 7 1 wherein the seal is carried on the housing.

Claim 19 (original): The pump of claim 12 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 20 (currently amended): The pump of claim 13 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the the vanes for extending the vane outwardly.

Claim 21 (currently amended): The pump of claim 9 1 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 22 (previously presented): The pump of claim 1 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 23 (previously presented): The pump of claim 22 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 24 (previously presented): The pump of claim 23 wherein the seal is formed by contact between the vane and rotor.

Claim 25 (original): The pump of claim 12 wherein the inlet flow valve is biased by a spring.

Claim 26 (original): The pump of claim 25 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 27 (currently amended): A variable displacement vane-type fluid pump, comprising:

- a housing defining a pump inlet through which fluid enters the pump, a pump outlet from which fluid is discharged under pressure and a fluid chamber between the pump inlet and pump outlet;

- a containment ring or eccentric ring pivotally carried by the housing within the fluid chamber for movement between a first position and a second position, the containment ring or eccentric ring having an interior opening with an internal surface;

- a rotor carried by the housing at least in part in the interior opening of the containment ring or eccentric ring, driven for rotation relative to the internal surface and having a plurality of slots extending radially inwardly into the rotor from an exterior of the rotor;

- a plurality of vanes carried by the rotor with a vane slidably received in each slot in the rotor;

- a first actuator responsive to a first fluid pressure and operable to pivot the containment ring or eccentric ring toward its first position;

- a second actuator responsive to a second fluid pressure and operable to pivot the containment ring or eccentric ring toward its second position; and

~~a control valve responsive to a first and a second feedback signal to control application of fluid pressure to the first and second actuators;~~

a control valve responsive to the differential between a first pressure signal and a second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions;

wherein control and positioning of the first and second actuators are a function of a combination of the first ~~feedback~~ pressure signal and the second ~~feedback~~ pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit; and

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator.

Claim 28 (previously presented): A variable displacement vane-type fluid pump, comprising:

a housing defining a pump inlet through which fluid enters the pump, a pump outlet from which fluid is discharged under pressure and a fluid chamber between the pump inlet and pump outlet;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an internal surface;

a rotor carried by the housing in the fluid chamber for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with a vane slidably received in each slot in the rotor;

a first actuator responsive to a first control pressure and operable to pivot the containment ring or eccentric ring in a first direction;

a second actuator responsive to a second control pressure and operable to pivot the containment ring or eccentric ring in a second direction;

a control valve responsive to a control pilot pressure to control application of the first fluid pressure to the first actuator, and responsive to a second control pressure to control application of the second fluid pressure to the second actuator; and

a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least one vane extends outwardly from the exterior of the rotor at all times.

Claim 29 (previously presented): The variable displacement vane-type fluid pump of claim 28 wherein the first actuator is a chamber formed between a portion of the containment ring and a portion of the housing.

Claim 30 (currently amended): A variable displacement vane-type fluid pump, comprising:

- a housing defining a pump inlet through which fluid enters the pump, a pump outlet from which fluid is discharged under pressure and a fluid chamber between the pump inlet and pump outlet;

- a containment ring or eccentric ring pivotally carried by the housing within the fluid chamber for movement between a first position and a second position, the containment ring or eccentric ring having an interior opening with an internal surface;

- a rotor carried by the housing at least in part in the interior opening of the containment ring or eccentric ring, driven for rotation relative to the internal surface and having a plurality of slots extending radially inwardly into the rotor from an exterior of the rotor;

- a plurality of vanes carried by the rotor with a vane slidably received in each slot in the rotor;

- a first actuator responsive to a first control pressure and operable to pivot the containment ring or eccentric ring toward its first position;

a second actuator responsive to a second control pressure and operable to pivot the containment ring or eccentric ring toward its second position; and

a control circuit responsive to engine conditions for providing a variable targeting of pump output wherein pressure from the oil circuit in the engine acts on the first actuator and pressure from the outlet acts on the second actuator for variable control of the containment ring in response to these conditions;

wherein control and positioning of the first and second actuators are a function of a combination of a first ~~feedback~~ pressure signal and a second ~~feedback~~ pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit;

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 31 (previously presented): The variable displacement vane-type fluid pump of claim 30 wherein the control circuit includes an actuator operatively connected

to one of the actuators for moving the containment ring in response to the control pressures.

Claim 32 (currently amended): A variable displacement vane pump, comprising:

- a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

- a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

- a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

- a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

- a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction; and

- a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction;

- wherein the first and second actuators are fluid acting directly on the containment ring;

wherein control and positioning of the first and second actuators are a function of a combination of a first feedback pressure signal and a second feedback pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit;

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 33 (currently amended): A variable displacement vane pump, comprising:

a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and

having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction;

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction;

a seal between the containment ring or eccentric ring and the housing defining a fluid chamber between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; ~~and~~

another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 34 (previously presented): The pump of claim 33 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 35 (previously presented): The pump of claim 34 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 36 (previously presented): The pump of claim 33 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 37 (previously presented): The pump of claim 36 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 38 (previously presented): The pump of claim 33 wherein the seal is carried by the containment ring or eccentric ring.

Claim 39 (previously presented): The pump of claim 35 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 40 (currently amended): The pump of claim 39 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the the vanes for extending the vane outwardly.

Claim 41 (previously presented): The pump of claim 35 wherein the inlet flow valve is biased by a spring.

Claim 42 (previously presented): The pump of claim 41 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 43 (previously presented): A variable displacement vane pump, comprising:

a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction;

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction; and

an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 44 (previously presented): The pump of claim 43 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 45 (previously presented): The pump of claim 43 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 46 (previously presented): The pump of claim 45 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 47 (previously presented): The pump of claim 43 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 48 (previously presented): The pump of claim 44 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 49 (previously presented): The pump of claim 45 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the vanes for extending the vane outwardly.

Claim 50 (previously presented): The pump of claim 43 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 51 (previously presented): The pump of claim 50 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 52 (previously presented): The pump of claim 51 wherein the seal is formed by contact between the vane and rotor.

Claim 53 (previously presented): The pump of claim 44 wherein the inlet flow valve is biased by a spring.

Claim 54 (previously presented): The pump of claim 53 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 55 (previously presented): A variable displacement vane pump, comprising:

a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction;

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction; and

a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 56 (previously presented): The pump of claim 55 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 57 (previously presented): The pump of claim 55 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 58 (previously presented): The pump of claim 55 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the vanes for extending the vane outwardly.

Claim 59 (previously presented): The pump of claim 55 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 60 (previously presented): The pump of claim 59 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 61 (previously presented): The pump of claim 60 wherein the seal is formed by contact between the vane and rotor.

Claim 62 (currently amended): A variable displacement vane pump, comprising:

a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction, wherein the first actuator is responsive to a first actuation pressure signal; and

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction, wherein the second actuator is responsive to a second actuation pressure signal;

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions,

application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 63 (previously presented): The pump of claim 62 wherein the first actuator is a piston slidably carried by the housing.

Claim 64 (previously presented): The variable displacement vane pump of claim 62 wherein the second direction is in a direction opposite of the first direction.

Claim 65 (previously presented): The pump of claim 62 wherein the second actuator is a piston slidably carried by the housing.

Claim 66 (previously presented): The pump of claim 62 wherein the first actuator includes a spring that in yielding biases the containment ring or eccentric ring in the first direction.

Claim 67 (canceled)

Claim 68 (previously presented): The pump of claim 67 which also comprises another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator.

Claim 69 (previously presented): The pump of claim 62 which also comprises a control valve responsive to a first fluid pressure signal to control application of the fluid under pressure to the first actuator, and responsive to a second fluid pressure signal to control application of the fluid under pressure to the second actuator.

Claim 70 (previously presented): The pump of claim 62 which also comprises a pivot pin about which the containment ring or eccentric ring pivots, the pivot pin defining a pivot axis of the containment ring or eccentric ring which is offset from the axis of the rotor by about one-half the maximum eccentricity of the containment ring or eccentric ring relative to the rotor.

Claim 71 (previously presented): The pump of claim 62 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 72 (previously presented): The pump of claim 71 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure

signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 73 (previously presented): The pump of claim 62 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 74 (previously presented): The pump of claim 73 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 75 (previously presented): The pump of claim 62 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 76 (previously presented): The pump of claim 67 wherein the seal is defined by direct contact between the containment ring or eccentric ring and the housing.

Claim 77 (previously presented): The pump of claim 67 wherein the seal is carried by the containment ring or eccentric ring.

Claim 78 (previously presented): The pump of claim 67 wherein the seal is carried on the housing.

Claim 79 (previously presented): The pump of claim 72 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 80 (currently amended): The pump of claim 73 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the the vanes for extending the vane outwardly.

Claim 81 (previously presented): The pump of claim 69 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 82 (previously presented): The pump of claim 62 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 83 (previously presented): The pump of claim 82 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 84 (previously presented): The pump of claim 83 wherein the seal is formed by contact between the vane and rotor.

Claim 85 (previously presented): The pump of claim 72 wherein the inlet flow valve is biased by a spring.

Claim 86 (previously presented): The pump of claim 85 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 87 (currently amended): A variable displacement pump system, comprising:

a pump assembly including a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the pump assembly under pressure;

a first actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a first displacement position; and

a second actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a second displacement position;

wherein control and positioning of the first and second actuators are a function of a combination of a first feedback pressure signal and a second feedback pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit;

an area defining a fluid chamber formed between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

a control valve responsive to the differential between the first pressure signal and the second pressure signal to selectively apply, based on engine conditions, application of fluid under pressure to either the first or second actuator based on engine conditions.

Claim 88 (canceled)

Claim 89 (previously presented): The pump of claim 87 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 90 (previously presented): The pump of claim 89 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 91 (previously presented): The pump of claim 88 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 92 (previously presented): The pump of claim 90 wherein the inlet flow valve is biased by a spring.

Claim 93 (previously presented): The pump of claim 92 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 94 (currently amended): A variable displacement pump system, comprising:

- a pump assembly including a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the pump assembly under pressure;

- a first actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a first displacement position; and

- a second actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a second displacement position;

- a flow control valve for mechanically varying the pump displacement;

- a compression spring connectable at a first spring end to a spool of the flow control valve, wherein the compression spring maintains pressure on the flow control valve during regular operation, and provides return pressure in the absence of a pilot pressure on the flow control valve; and

a target piston connected to the second end of the compression spring,
wherein the target piston exerts a force on the compression spring;

wherein control and positioning of the first and second actuators are a
function of a combination of a first feedback pressure signal and a second feedback
pressure signal taken from discrete locations separated by a degree of inherent
hydraulic resistance in a downstream fluid circuit acting on the target piston and the flow
control valve for providing a variable pressure target for regulation of the pump's
displacement in response to varying engine speeds; and

an area defining a fluid chamber formed between the housing and
containment ring or eccentric ring with fluid under pressure in the fluid chamber defining
the first actuator;

wherein the flow control valve is responsive to the differential between the
first pressure signal and the second pressure signal to selectively apply, based on
engine conditions, application of fluid under pressure to either the first or second
actuator based on engine conditions.

Claim 95 (previously presented): The pump of claim 94 wherein the target piston
is positioned in a bore, the target piston being located on a first side by a pressure from
a control input and on a second side by a grounded spring, the position in the bore
acting as a reference for a regulation system to provide a predetermined regulation
target pressure in the fluid circuit.

Claim 96 (previously presented): The pump of claim 95 wherein a multifunctional valve provides for varying the displacement of the pump by directing pressurized fluid to an on-stroke or de-stroke side of the pump assembly in response to the target piston acting on the multifunctional valve in a first direction, and a pressure input from the fluid circuit acting on the multifunctional valve in a second direction.

Claim 97 (previously presented): The pump of claim 96 wherein the multifunctional valve is a spool type valve having a biasing spring connected between the target piston and a spool valve, the target piston compressing the spring and biasing the spool valve for providing a target position in response to a control input from the pump assembly, the spool valve having passages for directing a control flow of fluid to the pump assembly, a control pressure from the fluid circuit acting on the spool valve against the biasing spring for seeking a predetermined target pressure.

Claim 98 (new): A variable displacement vane pump, comprising:
a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction;

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction;

wherein control and positioning of the first and second actuators are a function of a combination of a first pressure signal and a second pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit; and

a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 99 (new): The pump of claim 98 wherein the first actuator is a piston slidably carried by the housing.

Claim 100 (new): The variable displacement vane pump of claim 98 wherein the second direction is in a direction opposite of the first direction.

Claim 101 (new): The pump of claim 98 wherein the second actuator is a piston slidably carried by the housing.

Claim 102 (new): The pump of claim 98 wherein the first actuator includes a spring that in yielding biases the containment ring or eccentric ring in the first direction.

Claim 103 (new): The pump of claim 98 which also comprises a seal between the containment ring or eccentric ring and the housing defining a fluid chamber between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator.

Claim 104 (new): The pump of claim 103 which also comprises another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator.

Claim 105 (new): The pump of claim 98 which also comprises a control valve responsive to a first fluid pressure signal to control application of the fluid under

pressure to the first actuator, and responsive to a second fluid pressure signal to control application of the fluid under pressure to the second actuator.

Claim 106 (new): The pump of claim 98 which also comprises a pivot pin about which the containment ring or eccentric ring pivots, the pivot pin defining a pivot axis of the containment ring or eccentric ring which is offset from the axis of the rotor by about one-half the maximum eccentricity of the containment ring or eccentric ring relative to the rotor.

Claim 107 (new): The pump of claim 98 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 108 (new): The pump of claim 107 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 109 (new): The pump of claim 98 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 110 (new): The pump of claim 98 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 111 (new): The pump of claim 103 wherein the seal is defined by direct contact between the containment ring or eccentric ring and the housing.

Claim 112 (new): The pump of claim 103 wherein the seal is carried by the containment ring or eccentric ring.

Claim 113 (new): The pump of claim 103 wherein the seal is carried on the housing.

Claim 114 (new): The pump of claim 108 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 115 (new): The pump of claim 98 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the vanes for extending the vane outwardly.

Claim 116 (new): The pump of claim 105 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 117 (new): The pump of claim 98 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 118 (new): The pump of claim 117 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 119 (new): The pump of claim 118 wherein the seal is formed by contact between the vane and rotor.

Claim 120 (new): The pump of claim 108 wherein the inlet flow valve is biased by a spring.

Claim 121(new): The pump of claim 120 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 122 (new): A variable displacement vane pump, comprising:

- a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

- a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

- a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

- a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

- a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction;

- a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction;

- a seal between the containment ring or eccentric ring and the housing defining a fluid chamber between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator; and

another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator.

Claim 123 (new): The pump of claim 122 which also comprises an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 124 (new): The pump of claim 123 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 125 (new): The pump of claim 122 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 126 (new): The pump of claim 125 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 127 (new): The pump of claim 122 wherein the seal is carried by the containment ring or eccentric ring.

Claim 128 (new): The pump of claim 124 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 129 (new): The pump of claim 128 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the vanes for extending the vane outwardly.

Claim 130 (new): The pump of claim 124 wherein the inlet flow valve is biased by a spring.

Claim 131 (new): The pump of claim 130 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 132 (new): A variable displacement vane pump, comprising:
a housing defining a chamber, a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the housing under pressure;

a containment ring or eccentric ring pivotally carried by the housing for movement between a first position and a second position and defining an opening with an internal surface;

a rotor carried by the housing for rotation relative to the internal surface and having a plurality of slots extending inwardly into the rotor from an exterior of the rotor;

a plurality of vanes carried by the rotor with each vane slidably received in a slot in the rotor;

a first actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a first direction, wherein the first actuator is responsive to a first actuation pressure signal;

a second actuator responsive to application of fluid under pressure and operable to pivot the containment ring or eccentric ring in a second direction, wherein the second actuator is responsive to a second actuation pressure signal; and

an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 133 (new): The pump of claim 132 wherein the first actuator is a piston slidably carried by the housing.

Claim 134 (new): The variable displacement vane pump of claim 132 wherein the second direction is in a direction opposite of the first direction.

Claim 135 (new): The pump of claim 132 wherein the second actuator is a piston slidably carried by the housing.

Claim 136 (new): The pump of claim 132 wherein the first actuator includes a spring that in yielding biases the containment ring or eccentric ring in the first direction.

Claim 137 (new): The pump of claim 132 which also comprises a seal between the containment ring or eccentric ring and the housing defining a fluid chamber between the housing and containment ring or eccentric ring with fluid under pressure in the fluid chamber defining the first actuator.

Claim 138 (new): The pump of claim 137 which also comprises another fluid chamber defined at least in part by the seal with fluid under pressure in the another fluid chamber defining the second actuator.

Claim 139 (new): The pump of claim 132 which also comprises a control valve responsive to a first fluid pressure signal to control application of the fluid under

pressure to the first actuator, and responsive to a second fluid pressure signal to control application of the fluid under pressure to the second actuator.

Claim 140 (new): The pump of claim 132 which also comprises a pivot pin about which the containment ring or eccentric ring pivots, the pivot pin defining a pivot axis of the containment ring or eccentric ring which is offset from the axis of the rotor by about one-half the maximum eccentricity of the containment ring or eccentric ring relative to the rotor.

Claim 141 (new): The pump of claim 132 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 142 (new): The pump of claim 132 which also comprises a vane extension member carried by the housing and engageable with the vanes during at least certain positions of the rotor to ensure that at least two vanes extend outwardly from the exterior of the rotor at all times.

Claim 143 (new): The pump of claim 142 wherein the vane extension member is a ring carried by the rotor to engage at least two vanes at all times.

Claim 144 (new): The pump of claim 132 wherein the slots on the rotor extend radially inwardly of the rotor.

Claim 145 (new): The pump of claim 137 wherein the seal is defined by direct contact between the containment ring or eccentric ring and the housing.

Claim 146 (new): The pump of claim 137 wherein the seal is carried by the containment ring or eccentric ring.

Claim 147 (new): The pump of claim 137 wherein the seal is carried on the housing.

Claim 148 (new): The pump of claim 141 wherein fluid under pressure is communicated with the slots in the rotor to bias the vanes into contact with the cam surface.

Claim 149 (new): The pump of claim 142 wherein the vane extension member further comprises a ring portion for engaging the two rings and oil pressure acting on the vanes for extending the vane outwardly.

Claim 150 (new): The pump of claim 139 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 151 (new): The pump of claim 132 wherein the vanes have leading and trailing faces and the slots in the rotor are slightly wider than the vanes received in the slots so that a fluid film forms between the rotor and the leading and trailing faces of each vane.

Claim 152 (new): The pump of claim 151 further comprising a seal between a vane and the rotor to restrict fluid flow between them.

Claim 153 (new): The pump of claim 152 wherein the seal is formed by contact between the vane and rotor.

Claim 154 (new): The pump of claim 141 wherein the inlet flow valve is biased by a spring.

Claim 155 (new): The pump of claim 154 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 156 (new): A variable displacement pump system, comprising:

a pump assembly including a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the pump assembly under pressure;

a first actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a first displacement position;

a second actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a second displacement position;

wherein control and positioning of the first and second actuators are a function of a combination of a first pressure signal and a second pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit; and

an inlet flow valve responsive to a fluid pressure signal above a threshold pressure to permit a portion of fluid discharged from the pump outlet to flow into the pump inlet during at least some fluid flow conditions.

Claim 157 (new): The pump of claim 156 which also comprises a control valve responsive to a first and a second pressure signal to control application of fluid pressure to the first and second actuators.

Claim 158 (new): The pump of claim 156 wherein the inlet flow valve is yieldably biased to a position preventing fluid discharged from the pump outlet to flow into the inlet of the pump and is displaced by a sufficiently high fluid pressure signal to a position permitting fluid discharged from the pump outlet to flow into the pump inlet.

Claim 159 (new): The pump of claim 156 which also comprises an exhaust opening in the housing through which fluid in the fluid chamber is discharged under certain fluid flow conditions and wherein the control valve controls fluid flow from the fluid chamber through the exhaust opening in response to certain fluid pressures of the first and second pilot pressures.

Claim 160 (new): The pump of claim 158 wherein the inlet flow valve is biased by a spring.

Claim 161 (new): The pump of claim 160 wherein the inlet flow valve is further biased by a pilot pressure signal.

Claim 162 (new): A variable displacement pump system, comprising:

a pump assembly including a pump inlet through which fluid enters the housing and a pump outlet through which fluid is discharged from the pump assembly under pressure;

a first actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a first displacement position; and

a second actuator responsive to application of fluid under pressure and operable to cause displacement of the pump assembly towards a second displacement position;

a flow control valve for mechanically varying the pump displacement;

a compression spring connectable at a first spring end to a spool of the flow control valve, wherein the compression spring maintains pressure on the flow control valve during regular operation, and provides return pressure in the absence of a pilot pressure on the flow control valve; and

a target piston connected to the second end of the compression spring, wherein the target piston exerts a force on the compression spring;

wherein control and positioning of the first and second actuators are a function of a combination of a first pressure signal and a second pressure signal taken from discrete locations separated by a degree of inherent hydraulic resistance in a downstream fluid circuit acting on the target piston and the flow control valve for

providing a variable pressure target for regulation of the pump's displacement in response to varying engine speeds;

wherein the target piston is positioned in a bore, the target piston being located on a first side by a pressure from a control input and on a second side by a grounded spring, the position in the bore acting as a reference for a regulation system to provide a predetermined regulation target pressure in the fluid circuit.

Claim 163 (new): The pump of claim 162 wherein a multifunctional valve provides for varying the displacement of the pump by directing pressurized fluid to an on-stroke or de-stroke side of the pump assembly in response to the target piston acting on the multifunctional valve in a first direction, and a pressure input from the fluid circuit acting on the multifunctional valve in a second direction.

Claim 164 (new): The pump of claim 163 wherein the multifunctional valve is a spool type valve having a biasing spring connected between the target piston and a spool valve, the target piston compressing the spring and biasing the spool valve for providing a target position in response to a control input from the pump assembly, the spool valve having passages for directing a control flow of fluid to the pump assembly, a control pressure from the fluid circuit acting on the spool valve against the biasing spring for seeking a predetermined target pressure.